# Effects of Prescribed and Wildland Fire on Aquatic Ecosystems in Western Forests

## 2001 Progress Report

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**Summary**

This document is a progress report for research activities conducted in 2001 on the effects of fire on aquatic ecosystems by the Aldo Leopold Wilderness Research Institute - Rocky Mountain Research Station and the University of Montana. The goal of the study is to quantify and compare the ecological consequences of three fire conditions (unburned forests, prescribed understory fires, stand-replacement fires) on stream ecosystems using a variety of biotic and abiotic indicators. This project is a combination of two studies, one funded by the Region 1 and 4 National Fire Plan Adaptive Management and Monitoring Program (R1/4 NFP), and another by the Joint Fire Sciences Program (JFS) and conducted in collaboration with the USGS Forest and Rangeland Ecosystem Science Center (FRESC) in Corvallis, Oregon. The project is scheduled to begin in 2002, but we were able to use some limited alternative funding in 2001 to conduct a pilot study that focused on developing and refining appropriate methodology, locating study areas, and collecting baseline information on amphibians. We sampled 13 streams between 9 July and 26 August 2001 on the Payette National Forest, Idaho. Seven of these streams were located in the Frank Church-River of No Return Wilderness in watersheds that burned, at varying intensities, in the Diamond Peak Fire of 2000. Six streams were located in the South Fork Salmon sub-basin, an area that has not burned for 60-70 years due to human fire suppression and other conditions. In 432 transects sampled (transects = 1 m x stream width), we captured a total of 560 tadpoles and 21 juvenile or adult tailed frogs (*Ascaphus montanus*), and 33 larvae and 1 juvenile Idaho giant salamander (*Dicamptodon aterrimus*). Densities of tailed frog tadpoles and giant salamander larvae in study streams ranged from 0 - 1.33 and 0 - 0.11 individuals per $m^2$, respectively. Biomass of tailed frog tadpoles and giant salamander larvae in study streams ranged from 0 – 1.45 and 0 – 2.53 $g/m^2$, respectively. Based on preliminary analyses of these limited data, streams in burned watersheds tended to have less cover, higher water temperatures, more fine sediment, and lower densities and biomass of tailed frogs compared to populations in unburned watersheds. Idaho giant salamanders only occurred in four streams and may not be included in further analyses. Future research will include sampling additional streams in previously sampled drainages and in the Bitterroot River drainage, sampling burned and unburned reaches within a stream, evaluating differences in burn severity among watersheds, sampling for macroinvertebrates and periphyton, conducting water chemistry analyses, and monitoring watersheds before and after prescription burning in the South Fork Salmon sub-basin.

## Introduction

Prescription burning and certain lightning-ignited wildland fires are increasingly important management tools used to reduce fuel loads and restore the ecological integrity of western forests. Despite the increased use of fire as a forest restoration tool, there is inadequate information on the ecological effects of prescribed and wildland fires, particularly in aquatic ecosystems. The lack of information on the effects of fire on fish and aquatic wildlife is a major impediment to developing and evaluating fire management policies. In addition, several amphibian and salmonid species in the mountainous regions of the western U.S. are declining, and thus understanding the effects of fire on aquatic ecosystems is increasingly important.

The goal of this study is to quantify and compare the ecological consequences of the following fire conditions (our "treatments") on stream ecosystems:

1. unburned forests (fires absent for at least 70 yrs)
2. low severity understory and prescribed fires
3. high severity stand-replacement fires

Because stream communities often respond to disturbances in complex ways, this project will use multiple biotic and abiotic indicators to evaluate various fire conditions, including amphibians, invertebrates, periphyton, aquatic habitat conditions (temperature, water chemistry, discharge, sedimentation, and large woody debris) and riparian forests. In addition, we are using a multi-scale approach to compare "treatments". We will compare ecological conditions within burned and upstream/downstream unburned reaches of the same stream and among burned and unburned (reference) streams within watersheds. Some streams will be revisited every year (2001-2004), while others will only be visited once. To assess the generality of the watershed-level data, we will examine similarities of our research findings among different eco-regions across the northwestern United States, including tributaries of the following drainages:

1. South Fork Salmon River in central Idaho
2. Big Creek in central Idaho
3. Bitterroot River in western Montana
4. Rogue River in Siskiyou Mountains near the Oregon-California border
5. Umpqua River in southwestern Oregon
6. Wallowa Mountains in northeastern Oregon

The results of this study will provide critical information necessary for managers to (1) evaluate the immediate and long-term effects of alternative fire management activities on stream ecosystems, (2) assess how fire management affects the ecological integrity of aquatic ecosystems, and (3) identify potential opportunities to better manage for Threatened and Endangered aquatic species.

**Study Areas**

One of the goals of the pilot project was to locate study areas and sampling streams. In 2001 we focused sampling efforts on 13 small tributaries of Big Creek and South Fork Salmon River on the Payette National Forest, Idaho (Table 1). We considered Big Creek and South Fork Salmon sub-basins as two distinct study areas. In 2002, we will add four additional study areas, including the Bitterroot River region in Montana and Rogue, Umpqua, and Wallowa study areas in Oregon. Study areas and sampling streams were purposely selected, and thus our study will not attempt to make inferences to unstudied drainages in the northwestern United States. However, the replication of our methods in six study areas in Idaho, Montana, and Oregon should provide some perspective on the generality of our results.

We selected the Big Creek (Fig. 1) and Bitterroot River drainages because large, lightning-ignited fires (Diamond Peak Fire = 60,610 ha and Bitterroot Valley Fire Complex = 118,196 ha, respectively) burned through these remote mountains in the year 2000 providing a mosaic of burned and unburned watersheds. The Big Creek drainage was chosen specifically because of existing pre-fire data on amphibian occurrences. In 1994 and 1995, Charles R. Peterson and assistants (Idaho State University, Pocatello, ID) used an area constrained search method (10 m x stream width) to determine the occurrence of amphibian reproduction at 23 locations in 18 small streams in the Big Creek drainage (Table 2, Figs. 2 and 3). In addition, Dr. G. Wayne Minshall has monitored benthic macroinvertebrates, periphyton, and stream conditions in small tributaries of Big Creek since 1988 (Bowman and Minshall 2000).

The South Fork River drainage (Fig. 1) was selected to link with an existing study initiated in 1999 by Victoria Saab from the Rocky Mountain Research Station, Boise, Idaho. The goal of this study was to use prescribed fire to restore fire to the ponderosa pine ecosystem, reduce accumulation of fuels, improve wildlife habitat, and enhance riparian and fish habitats. Watersheds selected for this study were at least 600 ha in size, dominated by ponderosa pine cover types, between 1060-2000 m in elevation, and with streams that were thought to provide habitat for amphibians and/or salmonids (Saab et al. 2000). In the summer of 1999 and 2000, Kirk Lohman (National Park Service, Anchorage, AK) collected data on amphibian occurrences using time-constrained and area-constrained (Parks and Reegan only) search methods in 13 small streams in the South Fork Salmon drainage. Five of these streams are scheduled for prescription burning in May or early June 2003: Blackmare, Fitsum, Parks, Reegan, and Williams. Some of the remaining streams will be used as references for unburned conditions.

**Amphibian Sampling**

Another goal of the pilot study was to develop and refine appropriate methodology. In 2001, we focused on sampling for amphibians and stream habitat conditions. Sampling methodology was based on the Random-X Protocols developed by R.B. Bury and D.J. Major (USGS, BRD, FRESC, Corvallis, OR) and modified to meet our needs (see Appendix A). Within each stream, we randomly selected thirty 1 m (x variable stream width) transects in a 1.0 km stream reach. The starting point of each reach sampled was determined by size of stream and accessibility. Ideally, we wanted to sample each stream for 1.0 km upstream from its confluence with the next larger system (e.g., South Fork Salmon River or Big Creek) or for 1.0 km upstream from a road crossing. However, due to the large size of Blackmare, Buckhorn, and Fitsum creeks, we sampled 1.0 km reaches further upstream in these three watersheds (Fig. 4).

At each transect, we sampled for amphibians using kick-sampling and recorded life history information on all captured individuals. Kick sampling involves first removing all larger rocks and logs from the stream transect, and then disturbing the substrate immediately in front of two D-frame nets. Kick sampling is an effective method for capturing both tailed frogs and giant salamanders (Bury and Corn 1991).

Amphibians captured during kick-sampling were placed in a plastic bucket until the entire transect was sampled and all individuals could be measured. All captured individuals were measured to the nearest 1 mm (snout-vent length and total length) with a plastic ruler, weighed to the nearest 0.1 g for frog tadpoles or nearest 0.5 g for adults, juveniles, and salamander larvae with a Pesola spring scale. Each individual was then identified to species, life stage (adult, juvenile, metamorph, tadpole/larva), and sex. Captured animals were released back into the transect area. Tailed frog tadpoles were grouped by approximate age:

| | |
|---|---|
| 1 yr old | small, no legs present |
| 2 yr old | hind legs present, although not necessarily functional |
| 3 yr old | hind legs and front legs present, tadpole suctorial disk present |

Tadpoles transformed at the end of their third year and were considered metamorphs if their mouth resembled a juvenile frog-type mouth and was no longer a suctorial disk. Most tailed frogs in this stage retained a tadpole-like tail, which was in the process of resorption.

In this progress report, we summarized amphibian data as the total density, total biomass, and number of individuals captured by life stage and species per stream. Total density per species per stream was calculated by summing the number of individuals observed in each life stage and dividing by the total area surveyed. Total biomass per species per stream was calculated by summing the weight of individuals captured in each life stage and dividing by the total area surveyed.

**Habitat Measurements**

At each sampling transect, we measured the following habitat conditions: habitat type (pool, riffle, cascade), water depth, wetted width, flow, water temperature, substrate type, substrate embeddedness, submerged large woody debris, aquatic organic debris, undercut bank, and overstory cover <1 m and >1 m from the water surface, and transect aspect. The gradient of the reach sampled was measured at three locations (starting transect, approximately 500 m upstream, and final transect) using an inclinometer. Fine sediment deposition depth was measured at five locations in 10 pools in each stream. We recorded the type of burn in the riparian area within 5 m on either side of the stream transect center line using the following categories:

1. unburned
2. partially burned and foliage from trees and shrubs still alive and providing cover
3. burned with no living trees or shrubs

Details of these habitat measurements are described in Appendix A. The average of all measured values are summarized in Appendix B. To better understand the dynamics of temperature in burned streams, we placed 10 Onset Tidbit temperature data loggers in eight tributaries of Big Creek in September 2001. These instruments will monitor stream temperatures every hour until June 2002. Appendix C describes their location.

**Preliminary Results**

Between 9 July and 26 August 2001, we sampled 432 one meter transects (x stream width) in 13 streams on the Payette National Forest, Idaho (Table 1). Seven of these streams were tributaries of Big Creek located in the Frank Church-River of No Return Wilderness, an area that burned in the Diamond Peak Fire of 2000 (Fig. 2). Six streams were located in the South Fork Salmon sub-basin (Fig. 4) in watersheds that have not experienced large fires for 60-75 years due to fire suppression (Barrett 2000).

The following results should be considered preliminary and interpreted cautiously. This data set represents a small sample of a larger project (yet to be completed) and therefore may be overly influenced by a few cases. We report the information as a baseline for the study and precursor of future work that may or may not show similar patterns.

*Big Creek Study Area*

The Diamond Peak Fire burned 60,610 ha along the Big Creek drainage on the Payette National Forest in the summer of 2000. This stand-replacing fire burned both upland and riparian forests in many watersheds, particularly along valley bottoms. Of the seven streams surveyed, Cougar Creek had the least fire activity (Fig. 5). The riparian forest along Cabin Creek was a burn mosaic, while most of the forest along Canyon, Cave, Cliff, and Cow creeks was completely burned and little riparian regrowth had occurred by July 2001. The lower 0.5 km of Pioneer Creek was also mostly unburned due to fire suppression activities around Taylor Ranch, but just above the property the riparian vegetation along Pioneer Creek was completely burned.

Tailed frog tadpoles were found in 6 of 7 streams sampled in the Big Creek drainage in 2001, while no giant salamanders were observed in Big Creek. Despite the availability of appropriate habitat, Big Creek appears to be just outside the range of Idaho giant salamanders. Patterns of tailed frog occurrence in 2001 were similar to 1994/95 data, except tadpoles were not found in two streams in 1995 where we found them in 2001 (Table 2; Fig. 2). This difference may be associated with survey methods; we employed more intensive sampling in 2001 than Peterson did in 1994-95. Crystal Strobyl, an undergraduate from the University of Idaho in Moscow, revisited 17 streams in 2001 that were surveyed by Peterson in 1994-95 (Table 2). Strobyl, using a similar methodology as Peterson, found tailed frogs in only 7 of 17 streams surveyed compared to 14 of 18 streams where tailed frogs were found in 1994-95. All but two of the streams Strobyl sampled had burned to varying degrees in the summer of 2000. This apparent decline is far from conclusive; more intensive sampling is needed to determine the validity of this pattern. In the coming years, we hope to sample additional streams that were sampled in 1994 and 1995 to detect changes in tailed frog distributions (Fig. 3).

In streams where tailed frog tadpoles were observed, their frequency of occurrence in transects ranged from 10-72% (Table 4). The density and biomass of tailed frogs was highly variable among tributary streams of Big Creek, ranging from 0 to 0.893 tadpoles/$m^2$ and 0 to 0.78 g/$m^2$, respectively (Tables 6 and 7). Cougar Creek, the stream with the least burned riparian forest, had nearly twice the density and biomass of 1 year-old tailed frog tadpoles than any other stream sampled along Big Creek. However, the density and biomass of 2 and 3 year-old tadpoles in Cougar Creek were not as obviously different than other streams. If tailed frog hatchlings, which hatched in August and September, were the most sensitive life stage to disturbance, then we would expect the 1 year-old cohort in 2001 to show the greatest response to the fires of 2000. However, these differences may reflect other unmeasured characteristics of these stream ecosystems and further studies are needed to tease apart these subtleties. The actual number of individuals captured is listed in Table 7.

According to Taylor Ranch residents Jim and Holly Akenson, Crooked and Cow creeks were contributing the greatest amounts of sediment (ash, charcoal, inorganic fine sediments) to Big Creek resulting in a black film that covered rocks along the substrate. We witnessed one of these "blow-outs" on Cow Creek on 15 July following 30 minutes of rain. The clear water of Cow Creek became a black torrent of thick mud that completely clogged the mesh of our amphibian nets. At 1400 hrs, we recorded a conductivity of 50 µS in Cabin Creek, just above the confluence with Cow, while the conductivity in Cow Creek was >2000 µS. About 1-2 hours later, Cabin Creek, above the confluence with Cow, also turned black with suspended sediment. Upon our departure at 0800 on 16 July, both streams continued to flow with black suspended sediment. Despite this disturbance, we captured 59 tadpoles and 1 adult tailed frog in 60 transects along Cabin Creek between 6-8 and 11-12 August 2001. However, in 30 transects surveyed on Cow Creek from 6-7 August 2001, we did not capture a single tadpole and only one juvenile tailed frog. By August, the substrate of Cow Creek and Cabin Creek, below the confluence with Cow, was almost completely composed of silt and sand and both creeks were no longer flowing in their original channels due to sediment dams and scouring.

*South Fork Salmon River Study Area*

In 2001, we sampled 6 out of 13 streams that had been sampled for amphibians and invertebrates since 1999 (Table 3). Deadman, Dutch Oven, and Williams creeks did not support or had very small populations of tailed frogs and/or Idaho giant salamanders and may not continue to be monitored for amphibians (Saab et al. 2000). We found tailed frog tadpoles in all six streams sampled and Idaho giant salamanders in 4 of 6 streams (Fig. 4). In streams where giant salamanders were observed, their frequency of occurrence in transects ranged from 10-33%, whereas tailed frog tadpoles ranged from 10-73% (Table 4).

In streams where they were found, the densities of Idaho giant salamanders were considerably lower than tailed frogs (Table 5), but their total biomass was greater (Table 6). The densities and biomass of tailed frogs in the unburned watersheds of the South Fork Salmon drainage were significantly greater than those in the burned watersheds of the Big Creek drainage, but we can not discern whether these differences are attributable to habitat or fire history (Table 5, 6). The actual number of individuals captured is listed in Table 7.

At present, the prescribed burns on the Payette National Forest of interest to this study are proposed for late May/early June 2003. We are currently discussing the details of these burns with the fire and forest managers on the Payette National Forest. In addition, we have met with NFP scientists from the U.S. Fish and Wildlife Service and the National Marine Fisheries

Service.  We are hopeful that the prescribed burns will be conducted in 2003 on five watersheds in the South Fork Salmon area (Blackmare, Fitsum, Parks, Reegan, and Williams).  The timing of these burns is partly dependent on approval of NEPA analysis assessments.

Prescription burning has been and is continuing to be used on the Payette National Forest to reduce fuels in accordance with National Fire Plan objectives (Sam Hescock, Payette NF, personal communication).  Barrett (2000) suggested that future wildfires will likely be unnaturally severe in riparian zones where prescription burning is generally avoided.  Both the absence of fire in riparian forests and the potential for unnaturally severe fires in these stands in the future (or what has occurred in some of the Big Creek watersheds) may have significant effects on stream ecosystems.  Some of these effects may be positive in the short term and negative in the long term, or vice versa.  Different species may have different responses to disturbance and/or the lack thereof.  Understanding whether prescription burning simulates or mitigates the effects of natural wildland fire on stream ecosystems remains an important question.  We are hopeful that information from this study will improve our understanding of these complex dynamics and interactions.

**Plans for 2002**

In 2002, we will have four teams of two researchers continuing to monitor stream indicators (amphibians, invertebrates, periphyton, and habitat) in the 13 study streams and in at least 18 additional streams in Idaho and Montana.  In the coming year, Erin Hyde (USGS-FRESC) will coordinate at least two crews of two researchers to monitor approximately 30 streams in Oregon.  Based on research findings from 2001, we will not monitor lentic (lake and pond) habitats as planned.  Fewer than expected of these lentic habitats were located in areas burned in the summer 2000 fires and thus we feel that our time would be better spent focusing on stream habitats.

**Products and/or tech transfer expected in 2002**

We will be developing a web page for this project and posting goals of the project, descriptions of the study areas, and preliminary results.  We will also be collaborating with Bruce Bury, Erin Hyde, and Chris Pearl (USGS-FRESC) on a paper reviewing amphibian population responses to prescription burning, wildland fires, and salvage logging.  In April 2002, this paper will be presented at a technical workshop in Boise, Idaho and published in the proceedings.

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**Table 1. Streams sampled in the Big Creek and South Fork Salmon River drainages, Idaho in July and August 2001. Fire history includes the 1988 Golden Fire, 1991 Rush Point Fire, and 2000 Diamond Peak Fire, all of which occurred in the Frank Church - River of No Return Wilderness. Prescribed burns are planned for 4 watersheds in the South Fork Salmon drainage in 2003. Reference streams will remain unburned.**

| Streams | Drainage | Fire History | Date Sampled: July 1-15 | July 15-30 | Aug 1-15 | Aug 15-30 | # Transects | Total Creek Distance Sampled (km) | Sampling Location |
|---|---|---|---|---|---|---|---|---|---|
| Cabin | Big Creek | 2000 | | | x | | 60 | 2 | Three Regions:<br>1. From near lower trail crossing (15);<br>2. From confluence with Cow Creek (30);<br>3. From confluence with North Fork (15) |
| Canyon | Big Creek | 2000 | | | x | | 30 | 1 | From Big Creek |
| Cave | Big Creek | 2000 | | | x | | 30 | 1 | From 3 km above Big Creek |
| Cliff | Big Creek | 1988, 2000 | x | | | | 30 | 1 | From Big Creek |
| Cougar | Big Creek | 1988, 2000 | x | | | | 18 | 0.5 | From Big Creek |
| Cow | Big Creek | 2000 | | | x | | 30 | 1 | From confluence with Cabin Creek |
| Pioneer | Big Creek | 1991, 2000 | x | | | | 56 | 2 | From Big Creek |
| Blackmare | SF Salmon | Rx 2003 | | | | x | 30 | 1 | From confluence with South Fork Blackmare Creek |
| Buckhorn | SF Salmon | Reference | | x | | | 30 | 1 | North Fork, from confluence with West Fork Buckhorn Creek |
| Fitsum | SF Salmon | Rx 2003 | | | | x | 30 | 1 | About 1 km above confluence with North Fork Fitsum Creek |
| Four Mile | SF Salmon | Reference | | | | x | 30 | 1 | From road crossing |
| Parks | SF Salmon | Rx 2003 | | x | | | 28 | 1 | From road crossing |
| Reegan | SF Salmon | Rx 2003 | | x | | | 30 | 1 | From road crossing |
| **Total** | | | **3** | **3** | **4** | **3** | **432** | **14.5** | |

Table 2. Data on occurrence of tailed frog breeding and area searched in tributaries of Big Creek drainage, Frank Church - River of No Return Wilderness, Idaho. Note that search methodology was not consistent among years. Data from 1994 and 1995 were collected by Charles R. Peterson, Idaho State University, Pocatello, ID. Data from 2001 in the *Other Streams* category were collected by Crystal Strobyl, University of Idaho, Moscow, ID.

| | **Tailed Frog Tadpole Occurrence** | | | **Total Area Searched ($m^2$)** | | |
|---|---|---|---|---|---|---|
| **Streams Sampled** | **1994** | **1995** | **2001** | **1994** | **1995** | **2001** |
| Cabin Creek - Lower | - | + | + | 130 | 130 | 157 |
| Cabin Creek - Upper (above NF Cabin) | | + | + | | 50 | 57 |
| Canyon Creek - Lower | | - | + | | 20 | 52 |
| Cave Creek - Mouth | - | - | - | 750 | 20 | 10 |
| Cave Creek - Lower | | | + | | | 107 |
| Cliff Creek - Lower | - | + | + | 750 | 620 | 97 |
| Cliff Creek - Upper (above fork) | | + | | | 50 | |
| Cougar Creek - Lower | | + | + | | 40 | 44 |
| Cow Creek - Lower | | - | - | | 10 | 38 |
| Pioneer Creek - Lower | + | + | + | 1000 | 480 | 140 |
| **Other Streams in Big Creek drainage:** | | | | | | |
| Beaver Creek - Mouth | - | | - | 250 | | 120 |
| Beaver Creek - Upper (above Hand Ck) | + | | | 750 | | |
| Crooked Creek - Mouth | - | | - | 750 | | 90 |
| Crooked Creek - Upper (above Snowshoe Gulch) | + | | - | 250 | | 30 |
| Dunce Creek - Lower | | + | + | | 15 | 10 |
| Goat Creek - Lower | | + | + | | 15 | 10 |
| Holy Terror Creek - Mouth | + | | - | 75 | | 45 |
| Monumental Creek - Mouth | | | - | | | 75 |
| Monumental Creek - Lower | + | | | 750 | | |
| Monumental Creek - Upper (above Snowslide Ck) | - | | | 500 | | |
| Mud Creek - Mouth | + | | - | 75 | | 30 |
| Ramey Creek - Mouth | + | | - | 750 | | 25 |
| Rush Creek - Mouth | - | - | - | 1400 | 40 | 24 |
| Snowslide Creek - Mouth | + | | + | 75 | | 75 |
| Whiskey Creek - Mouth | - | | - | 75 | | 5 |
| Wild Horse Creek - Mouth | + | | + | 75 | | 30 |

Table 3. Data on occurrence of tailed frog and giant salamander breeding in tributaries of South Fork Salmon River, Idaho. Search methodology was not consistent among years. Data from 1999 and 2000 were collected by Kirk Lohman, NPS, Anchorage, AK.

| | **Tailed Frog Tadpole Occurrence** | | | **Giant Salamander Larvae Occurrence** | | |
|---|---|---|---|---|---|---|
| **Streams Sampled** | **1999** | **2000** | **2001** | **1999** | **2000** | **2001** |
| Blackmare Creek | | + | + | | - | - |
| Buckhorn Creek | + | + | + | - | - | + |
| Cow Creek | + | | | - | | |
| Deadman Creek | - | | | + | | |
| Dutch Oven Creek | - | | | - | | |
| Fitsum Creek | | + | + | | + | + |
| Four Mile Creek | | + | + | | + | + |
| Lick Creek | - | | | - | | |
| Maverick Creek | + | | | - | | |
| Parks Creek | + | + | + | - | - | - |
| Reegan Creek | + | + | + | + | + | + |
| Telephone Creek | - | | | - | | |
| Williams Creek | + | | | - | | |

Table 4. Percent of transects with tailed frog tadpoles or giant salamander larvae in 13 study streams in Big Creek and South Fork Salmon River drainages, Idaho. Each stream was surveyed once in July or August 2001.

| Stream | Study Area | Total # Transects | Percent with Tailed Frog Tadpoles | Percent with Giant Salamander Larvae |
|---|---|---|---|---|
| Cabin | Big Creek | 60 | 42 | 0 |
| Canyon | Big Creek | 30 | 20 | 0 |
| Cave | Big Creek | 30 | 13 | 0 |
| Cliff | Big Creek | 30 | 23 | 0 |
| Cougar | Big Creek | 18 | 72 | 0 |
| Cow | Big Creek | 30 | 0 | 0 |
| Pioneer | Big Creek | 56 | 52 | 0 |
| Blackmare | SF Salmon | 30 | 73 | 0 |
| Buckhorn | SF Salmon | 30 | 47 | 33 |
| Fitsum | SF Salmon | 30 | 10 | 17 |
| Four Mile | SF Salmon | 30 | 57 | 10 |
| Parks | SF Salmon | 28 | 36 | 0 |
| Reegan | SF Salmon | 30 | 27 | 27 |

Table 5. Density of tailed frogs and giant salamanders in the 13 streams sampled in Big Creek and South Fork Salmon River drainages, July-August 2001.

| | | | Tailed Frog Tadpole Density (#/$m^2$) | | | | |
|---|---|---|---|---|---|---|---|
| Stream | Study Area | Total Area Surveyed ($m^2$) | 1 yr old | 2 yr old | 3 yr old | All Tadpoles | Giant Salamander Larval Density (#/$m^2$) |
| Cabin | Big Creek | 213.5 | 0.178 | 0.014 | 0.084 | 0.276 | 0.000 |
| Canyon | Big Creek | 52.4 | 0.210 | 0.000 | 0.000 | 0.210 | 0.000 |
| Cave | Big Creek | 106.6 | 0.019 | 0.000 | 0.019 | 0.038 | 0.000 |
| Cliff | Big Creek | 97.1 | 0.082 | 0.021 | 0.021 | 0.124 | 0.000 |
| Cougar | Big Creek | 43.7 | 0.778 | 0.046 | 0.069 | 0.893 | 0.000 |
| Cow | Big Creek | 37.8 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Pioneer | Big Creek | 140.3 | 0.399 | 0.007 | 0.050 | 0.456 | 0.000 |
| Blackmare | SF Salmon | 82.7 | 1.015 | 0.000 | 0.157 | 1.173 | 0.000 |
| Buckhorn | SF Salmon | 128.1 | 0.453 | 0.078 | 0.187 | 0.718 | 0.109 |
| Fitsum | SF Salmon | 100.8 | 0.050 | 0.000 | 0.010 | 0.060 | 0.060 |
| Four Mile | SF Salmon | 105.5 | 0.882 | 0.095 | 0.351 | 1.327 | 0.028 |
| Parks | SF Salmon | 98.0 | 0.214 | 0.020 | 0.000 | 0.235 | 0.000 |
| Reegan | SF Salmon | 117.9 | 0.076 | 0.000 | 0.034 | 0.110 | 0.085 |

Table 6. Biomass of tailed frogs and giant salamanders in the 13 streams sampled in Big Creek and South Fork Salmon River drainages, July-August 2001.

| Stream | Study Area | Total Area Surveyed ($m^2$) | Tailed Frog Tadpole Biomass ($g/m^2$) 1 yr old | 2 yr old | 3 yr old | All Tadpoles | Giant Salamander Larval Biomass ($g/m^2$) |
|---|---|---|---|---|---|---|---|
| Cabin | Big Creek | 213.5 | 0.18 | 0.03 | 0.17 | 0.38 | 0.00 |
| Canyon | Big Creek | 52.4 | 0.28 | 0.00 | 0.00 | 0.28 | 0.00 |
| Cave | Big Creek | 106.6 | 0.02 | 0.00 | 0.03 | 0.05 | 0.00 |
| Cliff | Big Creek | 97.1 | 0.17 | 0.06 | 0.08 | 0.31 | 0.00 |
| Cougar | Big Creek | 43.7 | 0.55 | 0.10 | 0.13 | 0.78 | 0.00 |
| Cow | Big Creek | 37.8 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Pioneer | Big Creek | 140.3 | 0.22 | 0.03 | 0.11 | 0.36 | 0.00 |
| Blackmare | SF Salmon | 82.7 | 0.74 | 0.00 | 0.19 | 0.93 | 0.00 |
| Buckhorn | SF Salmon | 128.1 | 0.36 | 0.11 | 0.26 | 0.73 | 2.53 |
| Fitsum | SF Salmon | 100.8 | 0.03 | 0.00 | 0.01 | 0.04 | 1.58 |
| Four Mile | SF Salmon | 105.5 | 0.84 | 0.17 | 0.45 | 1.45 | 1.34 |
| Parks | SF Salmon | 98.0 | 0.10 | 0.03 | 0.00 | 0.13 | 0.00 |
| Reegan | SF Salmon | 117.9 | 0.02 | 0.00 | 0.05 | 0.08 | 1.39 |

Table 7. Number of tailed frog and Idaho giant salamander tadpoles or larvae, juveniles, and adults captured in tributary streams of Big Creek and South Fork Salmon River in July and August 2001. Sampling transects were 1 m x stream width and were sampled.

| | | | | Tailed Frogs | | | | | Giant Salamanders | |
|---|---|---|---|---|---|---|---|---|---|---|
| Stream | Study Area | # Transects | Area Searched ($m^2$) | 1st yr Tadpoles | 2nd yr Tadpoles | 3rd yr Tadpoles | Juveniles | Adults | Larvae | Juveniles |
| Cabin | Big Creek | 60 | 213.5 | 38 | 3 | 18 | 0 | 1 | 0 | 0 |
| Canyon | Big Creek | 30 | 52.4 | 11 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cave | Big Creek | 30 | 106.6 | 2 | 0 | 2 | 0 | 0 | 0 | 0 |
| Cliff | Big Creek | 30 | 97.1 | 8 | 2 | 2 | 1 | 1 | 0 | 0 |
| Cougar | Big Creek | 18 | 43.7 | 34 | 2 | 3 | 1 | 1 | 0 | 0 |
| Cow | Big Creek | 30 | 39.6 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Pioneer | Big Creek | 56 | 140.3 | 56 | 1 | 7 | 0 | 1 | 0 | 0 |
| Blackmare | SF Salmon | 30 | 85.5 | 84 | 0 | 13 | 2 | 9 | 0 | 0 |
| Buckhorn | SF Salmon | 30 | 128.1 | 58 | 10 | 24 | 1 | 1 | 12 | 1 |
| Fitsum | SF Salmon | 30 | 100.8 | 5 | 0 | 1 | 1 | 0 | 7 | 0 |
| Four Mile | SF Salmon | 30 | 105.5 | 93 | 10 | 37 | 0 | 0 | 4 | 0 |
| Parks | SF Salmon | 28 | 98.0 | 21 | 2 | 0 | 0 | 0 | 0 | 0 |
| Reegan | SF Salmon | 30 | 117.9 | 9 | 0 | 4 | 0 | 0 | 10 | 0 |
| Total | | 432 | 1328.9 | 419 | 30 | 111 | 7 | 14 | 33 | 1 |

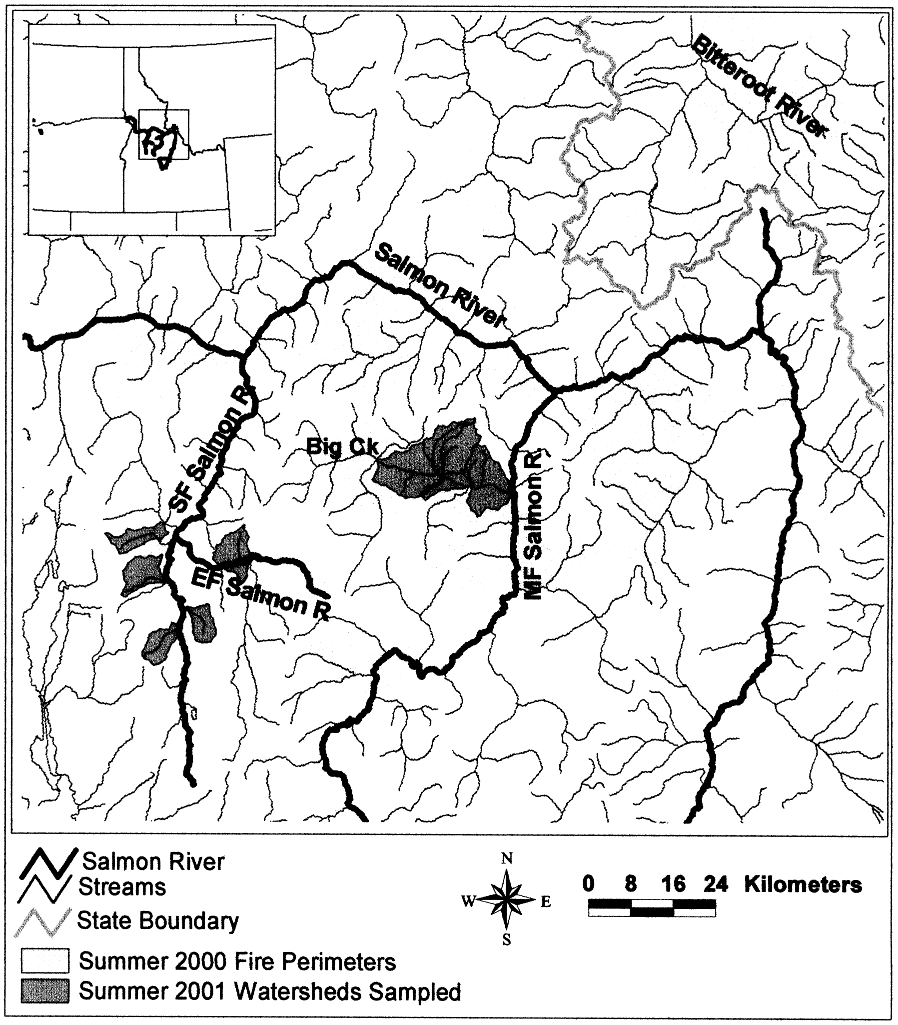


Figure 1. Map of the watersheds sampled in 2001. In 2002, additional watersheds will be sampled in the Big Creek, South Fork Salmon, and Bitteroot river drainages.

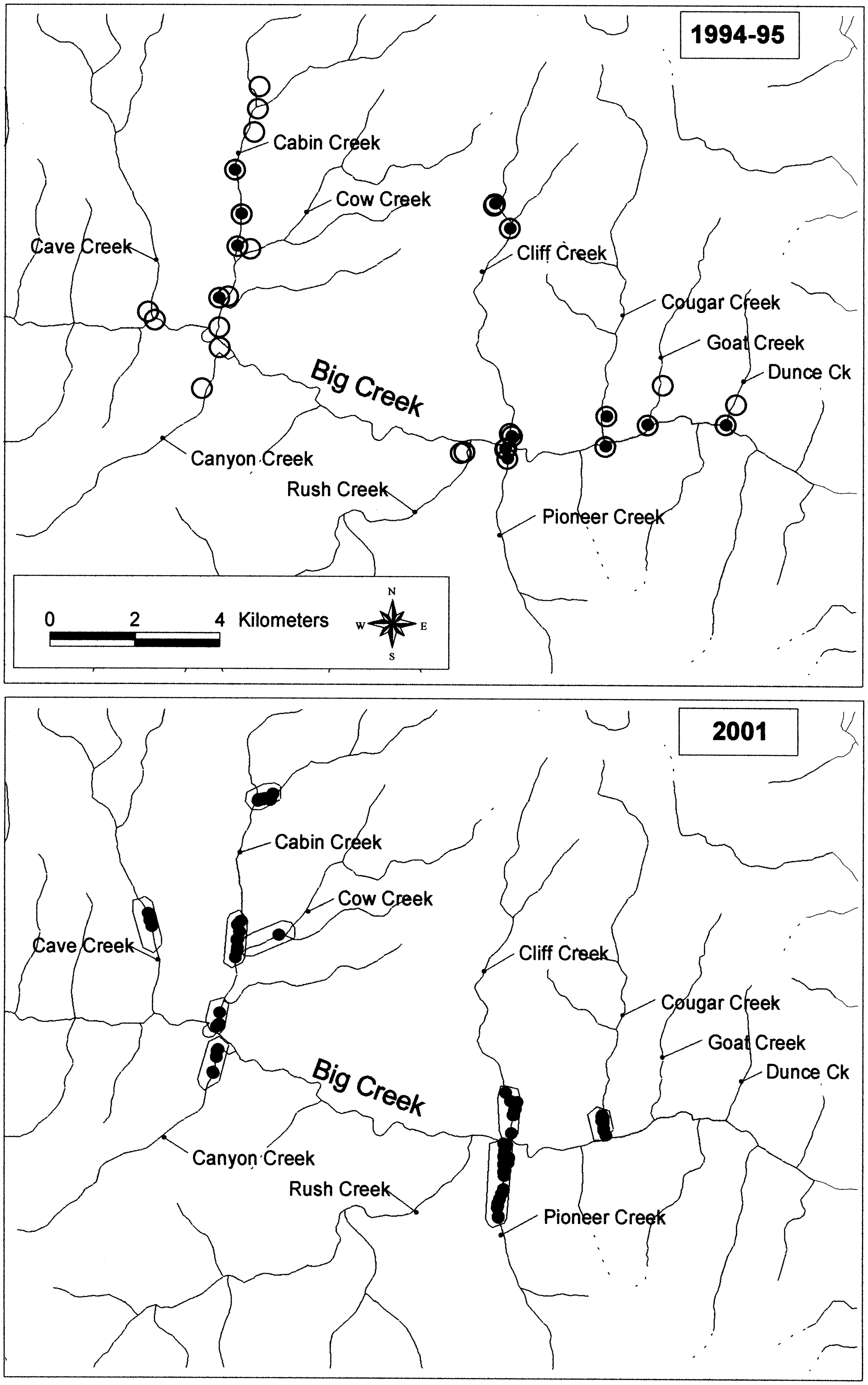


Figure 2. Streams sampled in the Big Creek watershed, Frank Church - River of No Return Wilderness, Idaho in 1994-95 (top) and 2001 (bottom). In 1994-95, large circles represent 10 m reaches surveyed. In 2001, oblong polygons represent the 0.5 - 2.0 km reaches sampled using 18-60 randomly located 1 m transects. Small filled circles represent capture locations of tailed frogs. Thick gray line and fill pattern represent the area burned in the Diamond Peak Fire in August-September 2000.

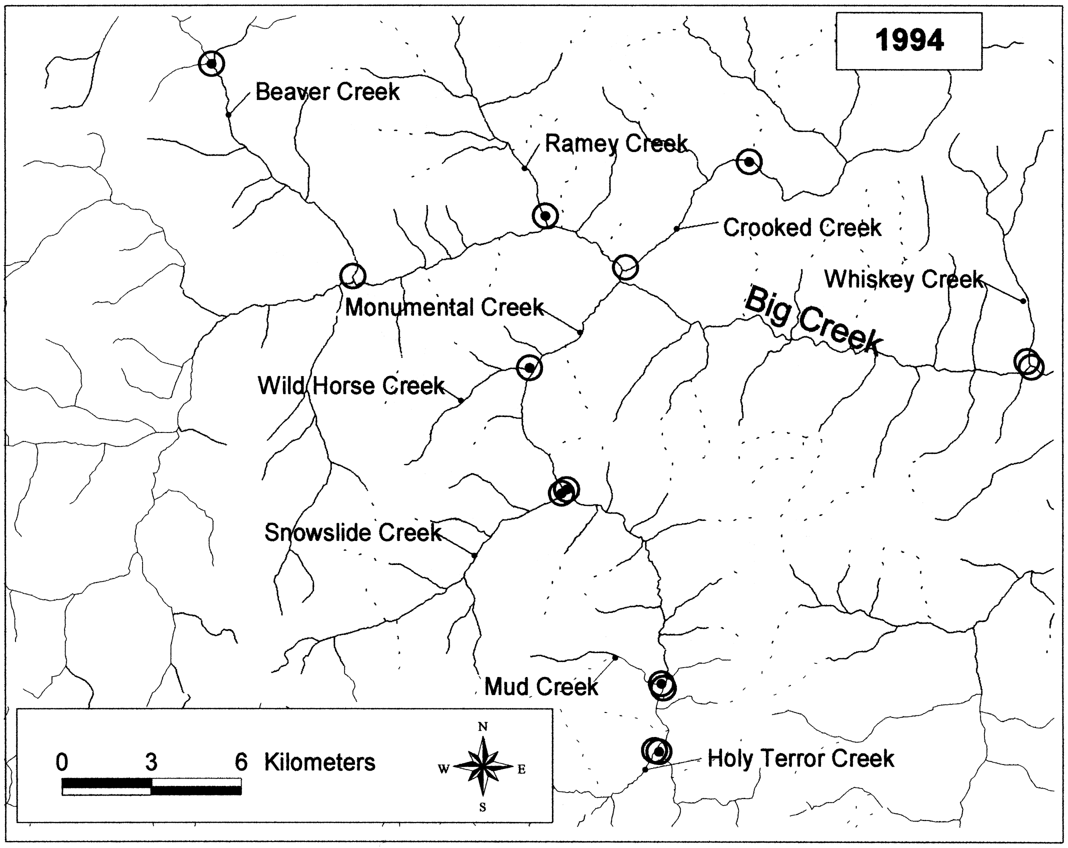


Figure 3. Streams sampled in the Big Creek watershed, Frank Church - River of No Return Wilderness, Idaho in 1994. Large circles represent 10 m reaches surveyed. Small filled circles represent capture locations of tailed frogs. Thick gray line and fill pattern represent the area burned in the Diamond Peak Fire in August-September 2000. These streams will be re-surveyed in 2002.

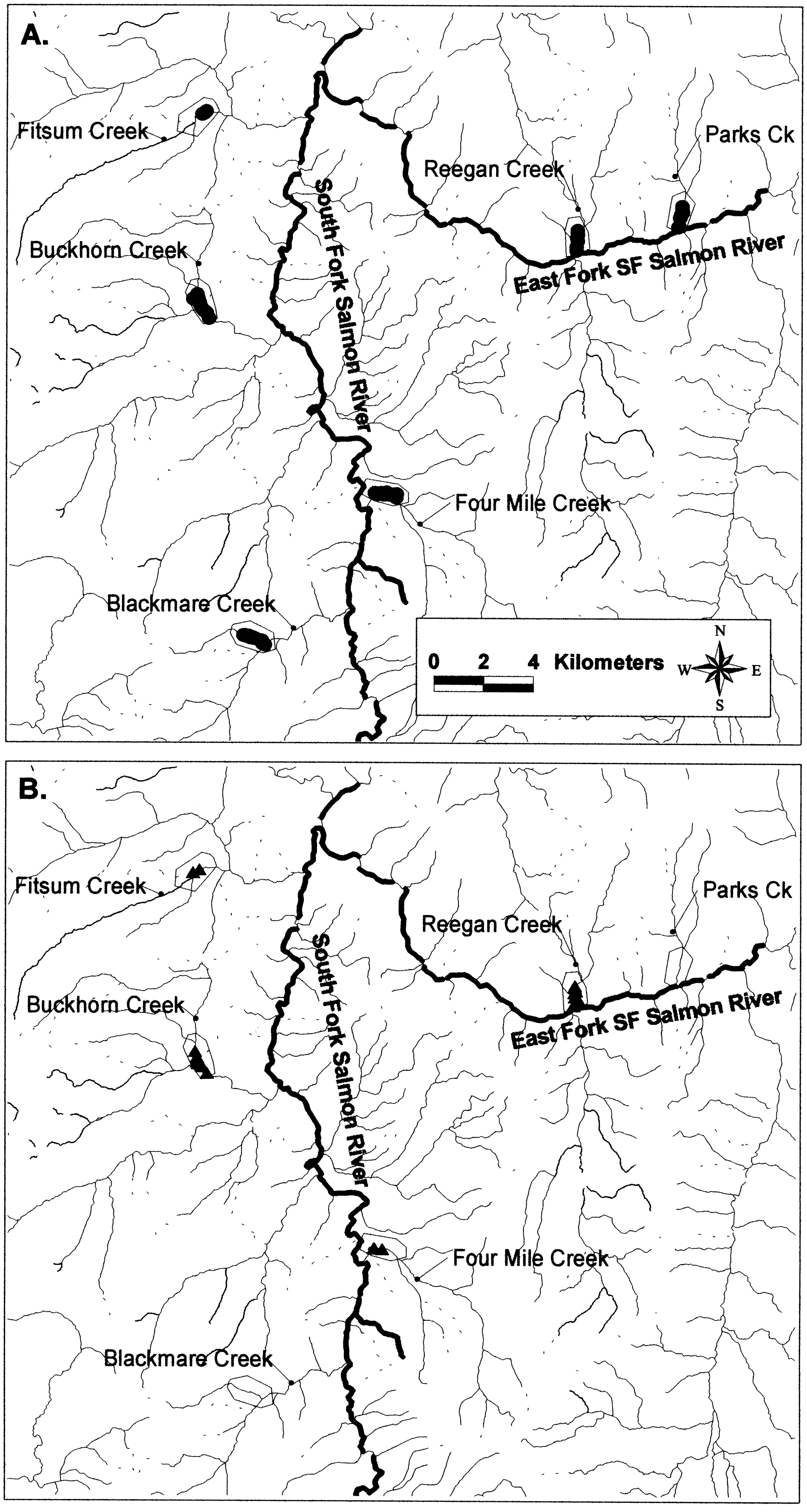


Figure 4. Streams sampled in the South Fork Salmon and East Fork of South Fork Salmon watersheds in July and August 2001. Oblong polygons represent 1.0 km reaches sampled using 28-30 randomly located 1 m transects. Small filled circles represent capture locations of tailed frogs (panel A) and small filled triangles represent capture locations of giant salamanders (panel B).

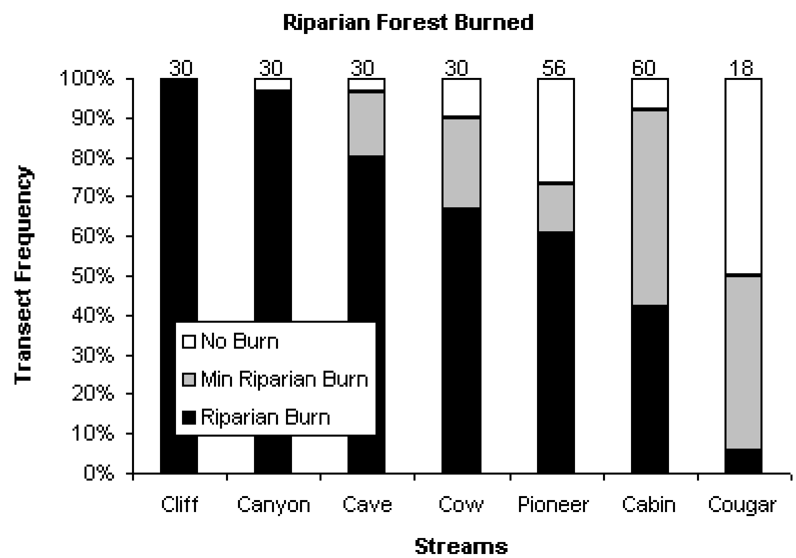


Figure 5. Percent of randomly located 1 m transects in each of three riparian forest burn categories in 7 streams surveyed in the Big Creek drainage, Idaho in July and August 2001. The number of transects in each stream are above each bar. See Table 1 for reach location and length of reach sampled in each stream.

Appendix A. Description of variables, methods used, and summary values presented in Appendix B for habitat and amphibian data recorded on stream survey transect data sheets, amphibian capture data sheets, and pool data sheets.

## Stream Survey Transect Data Sheet

### *Site Location and Habitat Description*

**Stream:** Stream name from topographic map.
**Drainage:** List the major drainage in the area (e.g., Big Creek, SF Salmon).
**State:** Use the two-letter abbreviation.
**Date:** Use MM/DD/YYYY format (e.g., 05/12/2002 for May 12, 2002).
**Trans #:** Every 1 m transect has a unique number. Use a unique five digit code YY### (e.g., 01251 is transect 251 in year 2001). This number is generally provided on the form. If the transect does not have a number ahead of time, record the transect number as YY999.
**Trans Dist:** This is the distance from the starting point of the stream section surveyed. This is a random number and is provided ahead of time. For example, "0" is used to indicate where the stream section survey starts. Using a tape measure, find the next transact by walking upstream from the upstream edge of the transect and measure to the downstream edge of the next transect. Units are in meters, but the nylon tape measure is usually in feet so use conversion table from notebook.
**Adjusted Distance:** If the random distance places the next transect in an unsurveyable part of the stream or if sample point is deemed unsafe by surveyors (e.g., waterfall, major log jam), then move upstream or downstream to the closest surveyable portion. Try to follow the scenarios: if large log across stream, survey immediately below log; if waterfall, survey at base of waterfall; if deep plunge pool, survey downstream shallows. Report the direction (up or down) and distance adjusted in meters. Start measuring the next distance from the upstream edge of the original transect.
**UTM:** Universal Transverse Mercator recorded as easting and northing from the GPS unit in meters. The map datum used by the GPS receiver will be NAD27 and zone 11.
**EPE:** Report the Estimated Positional Error from the GPS unit in meters. This is a rough estimate to evaluate unusually located points later.
**Observers:** Record the first, middle, and last initials of all individuals involved with the survey of this particular site. The person holding the nets is watching and should be included as an observer.
**Recorder:** Record the first, middle, and last initials of the recorder.
**Weather:** Record the weather at the start of each transect survey. Weather codes are: CL = clear, PC = partly cloudy, CO = cloudy. Precipitation codes are: D = dry, F = fog, M = mist, LR = light rain, HR = heavy rain. Wind codes are: C = calm, LB = light breeze, MB = moderate breeze, W = strong wind, G = gusty.
**Aspect:** Record the direction of water flow using a magnetic compass, reporting aspect in relation to true north (not magnetic north). Be sure to use a compass with appropriately adjusted declination (see topomap) or compute adjustment before recording. In Appendix B, average aspect is reported.
**Water Temp:** Record water temperature and report in °C = (°F – 32)/1.8. Thermometers should be placed in the water below the transect at the start of the survey and remain in the water for 3-5 minutes. In Appendix B, average water temperature is reported.
**Air Temp:** Record air temperature at chest height in the shade in °C. You should record air temperature before water temperature to avoid evaporative cooling on the bulb.
**Inclination:** Measure the slope taken at stream distance 0, ~500, and ~1000 m. Using a tape measure, measure 10 m between observers. Then, while holding the tape taut, have the downstream person record the slope at 1 m above the stream surface using an clinometer (in degrees). Use the 1 m mark on the net handles to take measurement and make sure the handle is on the water surface (use a rock or your wader boot). In Appendix B, gradient is reported the average of three measurements in degrees.
**Inclination Dist:** The distance between persons in meters. This will almost always be 10 m.
**Burn:** Using the centerline of the stream, estimate 5 m on either side of the stream. Describe if the riparian forest is burned using the following categories: 0 = unburned or at least no overstory cover vegetation was burned, 1 = partially burned with riparian foliage from trees and shrubs still alive and providing cover, 2 = burned with no living trees or shrubs providing cover.

**Survey Width:** The width of the survey area in centimeters. Usually this is the wetted width, but occasionally you will not survey a part of the transect because of thick deadfall or extensive braiding. We record survey width, because we use this measure to estimate the density and biomass of amphibians.
**Wet Depth:** Record the depth of the stream at three locations across the transect from left to right while facing upstream: left third (measured halfway between center and left bank), center, right third (measured halfway between center and right bank). Depth is recorded from marks on net handles to the nearest 2 cm. In Appendix B, depth is reported as a stream average of transect depths, which are calculated as an average of these 3 measurements taken per transect.
**Flow:** Using a submersible fishing bobber and line, fill the bobber with water so that it is neutrally buoyant and record the time it takes to travel 1 m downstream using a stopwatch. Repeat the measurement 3 times, recording each in seconds to the nearest 2 decimal places. In Appendix B, flow is calculated by dividing the flow measured in seconds by the distance the bobber traveled and then averaging across the 3 measurements.
**Flow Dist:** The distance the bobber was floated in meters. This is usually 1 m, but occasionally the current is such that it is easier to float the bobber along a 0.5 m section of stream.
**Substrate:** Substrate is visually classified into 2 categories (Dominant and Sub-dominant) based on substrate sizes modified from Platts et al. (1983) [from Lane 1947]. Size classes are as follows: 1 = silt, 2 = <1 mm, 3 = 1-2 mm, 4 = 2-4 mm, 5 = 4-8 mm, 6 = 8-16 mm, 7 = 16-32 mm, 8 = 32-64 mm, 9 = 64-160 mm, 10 = 160-256 mm, 11 = >256 mm. Non-rock materials are given the following classes: 12 = wood, 13 = bark, 14 = soil, 15 = vegetation, 16 = leaf litter. Visual categorization of the dominant and sub-dominant substrates is first recorded for the entire transect area. Then, record the number of times the dominant and sub-dominant substrate appear in a 10 cm x 30 cm view box moving along the downstream edge of the 1 m transect from left to right facing upstream. Finally record the total number of viewing areas (or calculate from stream width/30 cm). Appendix B reports the dominant and sub-dominant substrates as percentages by dividing the number of times each appeared in the viewing area by the total number of viewing areas, and then averaging these values for each stream.
**Pebble Counts:** In addition to the above method of substrate classification, we performed a Wolman Pebble Count (Wolman 1954) using a modified Platts et al. (1983) [from Lane 1947] substrate size classes. For our purposes, "pebbles" are any coarse substrate >9 mm measured along the intermediate axis (not the longest side and not the shortest side). Visually divide the stream into three equally sized sections from left to right; 10 pebbles will be measured from each of these three sections. Using the downstream edge of the 1 m transect and moving from left to right facing upstream, move your finger along the substrate and measure the size of each pebble your finger touches using a plastic ruler. Report the size of the first 10 pebbles encountered starting from the left bank, the first 10 encountered from the start of the next section, and the first 10 encountered from the start of the last section. In Appendix B, pebble counts are reported as the frequency of each particle size by dividing the number of pebbles in each size divided by the total number of pebbles counted; these are then reported as percentages.
**Embeddedness:** Embeddedness rates the degree that the larger particles (boulder, cobble, gravel) are surrounded or covered by fine sediment (<2 mm). Embeddedness estimation is conducted at the same time as the Pebble Count. For each pebble measured during the pebble count, report the degree of embeddedness as the percent of the "pebble" covered by fine sediment <2 mm. Use the following categories to describe the percent of the surface of each particle > 9 mm covered by fine sediment: 0-5%, 5-25%, 25-50%, 50-75%, 75-100%. In Appendix B, embeddedness is reported as the frequency of substrate particles in each embeddeness category by dividing the number of pebbles in each category by the total number of pebbles counted; these are then reported as percentages.
**Anchor:** This measure attempts to describe how "cemented" are the larger substrate particles. While conducting the Pebble Count, estimate (across the entire transect area) how hard it was to remove particles >9 mm. Use the following categories: 1 = no resistance, 2 = slight pull dislodges particles, 3 = particles unmovable or move with significant effort. The anchor may vary across the transect. If so, record an average. Sometimes the anchor will be "3" initially, but once you start removing larger objects the rests comes out easily. In this case, record the initial anchor value before disturbance.
**% LWD:** Estimate the percent of the entire transect area that is covered by in-stream large woody debris (>5 cm diameter) using the following categories: 0 %, 0-5%, 5-25%, 25-50%, 50-75%, 75-99%, or 100%.

**% OD:** Estimate the percent of the entire transect area that is covered by in-stream organic debris (wood <5 cm diameter, leaf litter) using the following categories: 0 %, 0-5%, 5-25%, 25-50%, 50-75%, 75-99%, or 100%.
**% UB:** Estimate the percent of the entire transect area that extends into and is covered by an undercut bank using the following categories: 0 %, 0-5%, 5-25%, 25-50%, 50-75%, 75-99%, or 100%.
**% Cover <1 m:** Estimate the percent of the entire transect area that has overhanging vegetation or other shading cover (such as a large log) <1 m from the water surface using the following categories: 0 %, 0-5%, 5-25%, 25-50%, 50-75%, 75-99%, or 100%.
**% Cover >1 m:** Estimate the percent of the entire transect area that has overhanging vegetation or other shading cover (such as a large log) >1 m from the water surface using the following categories: 0 %, 0-5%, 5-25%, 25-50%, 50-75%, 75-99%, or 100%.
**Environment:** Describe the dominant habitat type (Overton et al. 1997) for the transect using the following categories: C = cascade, composed of turbulent water coming over the top of rocks and forming white water or falls, HGR = high gradient riffle, composed of turbulent water moving around rocks and forming some white water, LGR = low gradient riffle, composed of slightly turbulent water moving around rocks and not forming any white water and may include some runs and glides, PP = plunge pool, composed of scoured turbulent pool at base of falls, P = pool, composed of slow non-turbulent water. In Appendix B, we report the frequency of different habitat types in each stream by dividing the total number of transects in each habitat type by the total number of transects; these are reported as percentages.
**Debris Vol:** This measurement is recorded after the amphibian survey has been completed. Record the total volume of debris that accumulates in the amphibian nets during kick-sampling. In Appendix B, debris volume is reported as a stream average.
**Debris Comp:** Record the dominant and sub-dominant debris type found in the amphibian nets after kick-sampling using the categories described under *Substrate*. This helps describe the fine sediment, vegetation, and debris that may be filling interstitial spaces the substratum or coating the surface of the rocks. In Appendix B, we report this measurement as a stream average.
***Amphibian Surveys***
**Begin Time:** List the time the survey began in 24 hour format.
**End Time:** List the time the survey ended in 24 hour format.
**Amphibian Date:** For each species, record the species (TF = tailed frog, GS = giant salamander). Record the total number of individuals observed (not just captured) for each life stage.
**Fish:** Record whether fish were observed in the net or visually.
**Fish Species:** Record what fish species were observed or captured as trout (includes char), sculpin, or other.
**Camera Number:** If photo taken, record the equipment identification number on the camera.
**Photo Frame Number(s) / Descriptions:** If photo taken, record the number of the photo as viewed on the camera's view screen. Briefly describe the photo subject in the comments field.
**Comments:** Comment on anything noteworthy about the weather, location, animals captured, or survey.
**Field Check:** Record the initials of the person checking the field form. This person should be someone other than the recorder.

**Amphibian Capture Data Sheet**
**Stream:** Stream name from topographic map.
**Dates:** Record the start and end dates for the stream survey period. Use MM/DD/YYYY format.
**Trans#:** Record the transect number. This number MUST match the number on the Stream Survey Transect Data Sheet.
**Animal ID:** Use the 5-digit transect number and add a two digit number to identify the individual starting with 01 for the first capture of that transect. The first animal captured in each new transect should start with YY###01.
**Species:** Record the species captured. TF = tailed frog, GS = giant salamander.

**Life stage:** Record the life stage of the individual captured: A = adult, J = juvenile, M = metamorph (for tailed frogs - may have tail, but no longer has suctorial mouth parts), T/L = tadpole or larvae (for tailed frogs – must have suctorial mouth parts), E = eggs.
**Sex:** Record the sex of the animal as male, female, unknown.
**# Legs:** Record the number of legs present as 0, 2, or 4. Limb buds are not recorded as legs. The limb must be functional (animal can move it) and have digits.
**SVL:** Record the length of the animal from snout to vent using a plastic ruler to the nearest mm. The best way to do this is to put the animal in a plastic bag first (also used to weigh the animal).
**TL:** Record the total length of the animal from snout to the tip of the tail using a plastic ruler to the nearest mm.
**Wt:** Record the weight of the animal by placing in a plastic bag and hanging from a Pesola spring scale. Try to avoid putting excess water in the bag. The only water should come off the skin of the animal. Record tailed frog tadpoles and metamorphs to the nearest 0.1 g and adult tailed frogs and giant salamanders to the nearest 0.5 g.
**Tare:** Record the weight of the plastic bag after removing the animal. Be careful not to drain any water from the bag when removing the animal for release. The bag weight should include this small amount of water.
**Comments:** Record any comments about the animal that are unusual. Use the following short-hand: 1 = Non-functional hind leg nubbins, 2 = Escaped, 3 = Dead, 4 = Collected, 5 = Collected toe tissue, 6 = Other. Note: all individuals should be recorded on this form even if they escaped before processing or were observed but not captured (this would only be the case if no animals were captured but one was observed or if one was observed but not captured on the last netting). If tissue is collected, record the animal #, date, and stream on the sample vial and on a tag placed inside the vial.

**<u>Pool Data Sheet</u>**
**Stream:** Stream name from topographic map.
**Dates:** Record the start and end dates for the stream survey period. Use MM/DD/YYYY format.
**Pool#:** Record the pool number starting with YY##. For example, pool two in 2001 would be 0202. As surveyors walk upstream, choose one pool every 100 m or so and record the following measurements.
**UTM:** Record the Universal Transverse Mercator Easting and Northing from the GPS unit in meters. The map datum used by the GPS receiver will be NAD27 and zone 11.
**EPE:** Report the Estimated Positional Error from the GPS unit in meters. This is a rough estimate to evaluate unusually located points later.
**Sediment Depth:** Measure the depth of sediment at 5 locations relative to the thalwag: the upstream edge of the pool, the center of the pool, the downstream edge of the pool, between the thalwag and left side of the pool, between the thalwag and right side of the pool. If the thalwag is not evident, use the midline of the stream. At these 5 locations in the pool, push a stake into the sediment until it stops. Slide your hand down the stake to the substrate surface and remove the stake. Measure the depth of sediment in mm.
**Pool Size:** Approximate the width and length of the pool to the nearest 0.5 m. This rough estimate provides a way of distinguishing major differences between pools of varying size.
**Pool Depth:** Measure the maximum depth of the pool to the nearst cm.

Appendix B. Habitat characteristics of 13 streams on the Payette National Forest, Idaho surveyed in July and August 2001.

| Stream | Study Area | Aspect Degrees | Width cm | Depth cm | Gradient Degrees | % Transects Pool | % Transects Low Grad. Riffle | % Transects High Grad. Riffle | % Transects Cascade | Flow m/s |
|---|---|---|---|---|---|---|---|---|---|---|
| Cabin | Big Creek | 202.4 | 355.9 | 16.6 | 2.5 | 0 | 62 | 33 | 3 | 1.45 |
| Canyon | Big Creek | 132.3 | 174.5 | 6.5 | 6.7 | 7 | 63 | 23 | 7 | 1.69 |
| Cave | Big Creek | 181.4 | 355.4 | 13.8 | | 0 | 87 | 13 | 0 | 1.63 |
| Cliff | Big Creek | 180.7 | 323.7 | 16.7 | 7.0 | 10 | 47 | 7 | 37 | 1.29 |
| Cougar | Big Creek | 162.9 | 242.7 | 15.1 | | 0 | 72 | 22 | 6 | 1.55 |
| Cow | Big Creek | 247.7 | 131.8 | 7.4 | 3.0 | 0 | 90 | 7 | 3 | 1.17 |
| Pioneer | Big Creek | 121.5 | 250.5 | 15.2 | | 7 | 27 | 38 | 29 | 1.41 |
| Blackmare | SF Salmon | 112.3 | 285.1 | 11.6 | | 0 | 63 | 33 | 3 | 1.98 |
| Buckhorn | SF Salmon | 153.7 | 426.9 | 18.6 | | 0 | 67 | 20 | 13 | 1.83 |
| Fitsum | SF Salmon | 90.6 | 336.0 | 15.2 | 3.3 | 0 | 53 | 37 | 10 | 1.63 |
| Four Mile | SF Salmon | 275.5 | 351.7 | 21.7 | 5.0 | 0 | 40 | 50 | 10 | 1.59 |
| Parks | SF Salmon | 205.2 | 350.2 | 16.7 | 5.0 | 11 | 50 | 25 | 14 | 1.92 |
| Reegan | SF Salmon | 194.5 | 392.9 | 18.6 | | 0 | 50 | 20 | 30 | 2.04 |

| Stream | Study Area | Maximum Tw C | Minimum Tw C | Average Tw C | % Cover <1m | % Cover >1 m | % Large Woody Debris | % Organic Debris | % Undercut Bank |
|---|---|---|---|---|---|---|---|---|---|
| Cabin | Big Creek | 20.0 | 11.0 | 15.3 | 10.7 | 17.3 | 3.7 | 7.2 | 1.4 |
| Canyon | Big Creek | 18.0 | 10.5 | 14.8 | 4.0 | 3.3 | 3.3 | 11.7 | 1.2 |
| Cave | Big Creek | 19.0 | 11.0 | 16.0 | 10.2 | 8.7 | 1.7 | 6.2 | 1.3 |
| Cliff | Big Creek | 18.0 | 12.0 | 14.7 | 3.8 | 5.3 | 2.0 | 6.7 | 3.0 |
| Cougar | Big Creek | 15.3 | 12.5 | 14.3 | 7.8 | 50.3 | 3.6 | 9.2 | 5.8 |
| Cow | Big Creek | 21.0 | 11.0 | 16.9 | 9.3 | 20.5 | 1.7 | 4.5 | 3.5 |
| Pioneer | Big Creek | 19.0 | 10.0 | 15.0 | 16.8 | 26.6 | 7.7 | 7.7 | 9.6 |
| Blackmare | SF Salmon | 11.0 | 7.0 | 9.2 | 17.7 | 59.3 | 4.2 | 7.5 | 0.3 |
| Buckhorn | SF Salmon | 15.0 | 9.0 | 12.4 | 19.2 | 29.0 | 2.7 | 5.2 | 1.0 |
| Fitsum | SF Salmon | 13.0 | 10.0 | 11.6 | 9.5 | 27.2 | 4.0 | 5.5 | 0.8 |
| Four Mile | SF Salmon | 13.0 | 9.5 | 11.3 | 12.2 | 16.7 | 2.5 | 4.7 | 0.5 |
| Parks | SF Salmon | 14.5 | 10.0 | 12.6 | 7.5 | 22.0 | 1.4 | 4.5 | 0.5 |
| Reegan | SF Salmon | 14.0 | 9.5 | 11.9 | 13.8 | 17.7 | 2.7 | 5.2 | 1.0 |

Appendix B. Habitat characteristics of 13 streams on the Payette National Forest, Idaho surveyed in July and August 2001.

| | | Total Substrate Particles | Frequency of Substrate Particles >9 mm | | | | | |
|---|---|---|---|---|---|---|---|---|
| Stream | Study Area | > 9 mm Counted | % 9-16 mm | % 17-32 mm | % 33-64 mm | % 65-160 mm | % 161-256 mm | % 256+ mm |
| Cabin | Big Creek | 1846 | 22.8 | 21.6 | 22.9 | 23.7 | 6.4 | 2.5 |
| Canyon | Big Creek | 904 | 20.7 | 35.5 | 24.0 | 15.9 | 2.3 | 1.5 |
| Cave | Big Creek | 952 | 17.0 | 22.5 | 27.0 | 27.0 | 5.1 | 1.4 |
| Cliff | Big Creek | 0 | | | | | | |
| Cougar | Big Creek | 0 | | | | | | |
| Cow | Big Creek | 718 | 33.0 | 28.6 | 21.7 | 10.7 | 2.1 | 3.9 |
| Pioneer | Big Creek | 0 | | | | | | |
| Blackmare | SF Salmon | 953 | 13.4 | 17.3 | 24.3 | 30.4 | 8.5 | 6.0 |
| Buckhorn | SF Salmon | 788 | 4.8 | 16.6 | 19.9 | 28.2 | 13.8 | 16.6 |
| Fitsum | SF Salmon | 842 | 9.0 | 17.9 | 18.5 | 31.7 | 13.1 | 9.7 |
| Four Mile | SF Salmon | 888 | 13.1 | 16.9 | 16.1 | 27.6 | 11.6 | 14.8 |
| Parks | SF Salmon | 445 | 5.8 | 7.6 | 18.4 | 34.2 | 14.8 | 19.1 |
| Reegan | SF Salmon | 825 | 6.8 | 12.1 | 20.5 | 31.8 | 10.9 | 17.9 |

| | | Total Substrate Particles | Frequency of Substrate Particles >9 mm in 5 Levels of Embeddedness | | | | |
|---|---|---|---|---|---|---|---|
| Stream | Study Area | > 9 mm Counted | 0-5% | 5-25% | 25-50% | 50-75% | 75-100% |
| Cabin | Big Creek | 1846 | 27.0 | 28.7 | 20.8 | 12.1 | 11.4 |
| Canyon | Big Creek | 904 | 38.0 | 29.9 | 21.2 | 8.7 | 2.2 |
| Cave | Big Creek | 952 | 29.1 | 29.3 | 23.0 | 9.5 | 9.1 |
| Cliff | Big Creek | 0 | | | | | |
| Cougar | Big Creek | 0 | | | | | |
| Cow | Big Creek | 718 | 25.2 | 27.5 | 24.1 | 13.7 | 9.5 |
| Pioneer | Big Creek | 0 | | | | | |
| Blackmare | SF Salmon | 953 | 35.7 | 23.4 | 25.7 | 10.5 | 4.6 |
| Buckhorn | SF Salmon | 788 | 41.3 | 27.6 | 23.6 | 4.5 | 3.1 |
| Fitsum | SF Salmon | 842 | 39.2 | 30.1 | 16.8 | 8.9 | 5.0 |
| Four Mile | SF Salmon | 888 | 39.5 | 30.4 | 18.7 | 6.9 | 4.5 |
| Parks | SF Salmon | 445 | 66.4 | 18.1 | 13.3 | 1.4 | 0.9 |
| Reegan | SF Salmon | 825 | 39.1 | 26.4 | 21.9 | 8.5 | 4.1 |

Appendix B. Habitat characteristics of 13 streams on the Payette National Forest, Idaho surveyed in July and August 2001.

| | | % Transects Silt Substrate | | % Transects <1 mm Substrate | | % Transects 1-2 mm Substrate | |
|---|---|---|---|---|---|---|---|
| Stream | Study Area | Dom | Sub Dom | Dom | Sub Dom | Dom | Sub Dom |
| Cabin | Big Creek | 0.0 | 5.0 | 15.0 | 8.3 | 3.3 | 5.0 |
| Canyon | Big Creek | 0.0 | 0.0 | 0.0 | 3.3 | 0.0 | 0.0 |
| Cave | Big Creek | 0.0 | 0.0 | 0.0 | 20.7 | 0.0 | 10.3 |
| Cliff | Big Creek | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Cougar | Big Creek | 0.0 | 0.0 | 0.0 | 5.6 | 5.6 | 0.0 |
| Cow | Big Creek | 0.0 | 13.3 | 70.0 | 10.0 | 3.3 | 3.3 |
| Pioneer | Big Creek | 0.0 | 0.0 | 0.0 | 0.0 | 1.8 | 3.6 |
| Blackmare | SF Salmon | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 23.3 |
| Buckhorn | SF Salmon | 0.0 | 0.0 | 0.0 | 0.0 | 3.3 | 3.3 |
| Fitsum | SF Salmon | 0.0 | 0.0 | 3.3 | 0.0 | 0.0 | 0.0 |
| Four Mile | SF Salmon | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.3 |
| Parks | SF Salmon | 0.0 | 0.0 | 3.6 | 0.0 | 0.0 | 0.0 |
| Reegan | SF Salmon | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

| | | % Transects 3-4 mm Substrate | | % Transects 5-8 mm Substrate | | % Transects 9-16 mm Substrate | |
|---|---|---|---|---|---|---|---|
| Stream | Study Area | Dom | Sub Dom | Dom | Sub Dom | Dom | Sub Dom |
| Cabin | Big Creek | 0.0 | 1.7 | 0.0 | 0.0 | 0.0 | 0.0 |
| Canyon | Big Creek | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Cave | Big Creek | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Cliff | Big Creek | 0.0 | 0.0 | 0.0 | 6.7 | 0.0 | 0.0 |
| Cougar | Big Creek | 5.6 | 5.6 | 0.0 | 0.0 | 0.0 | 0.0 |
| Cow | Big Creek | 0.0 | 3.3 | 0.0 | 0.0 | 3.3 | 3.3 |
| Pioneer | Big Creek | 3.6 | 1.8 | 1.8 | 3.6 | 0.0 | 5.4 |
| Blackmare | SF Salmon | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Buckhorn | SF Salmon | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Fitsum | SF Salmon | 0.0 | 3.3 | 3.3 | 0.0 | 0.0 | 0.0 |
| Four Mile | SF Salmon | 0.0 | 3.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| Parks | SF Salmon | 0.0 | 3.6 | 0.0 | 0.0 | 0.0 | 0.0 |
| Reegan | SF Salmon | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Appendix B. Habitat characteristics of 13 streams on the Payette National Forest, Idaho surveyed in July and August 2001.

| | | % Transects 17-32 mm Substrate | | % Transects 33-64 mm Substrate | | % Transects 65-160 mm Substrate | |
|---|---|---|---|---|---|---|---|
| Stream | Study Area | Dom | Sub Dom | Dom | Sub Dom | Dom | Sub Dom |
| Cabin | Big Creek | 1.7 | 1.7 | 30.0 | 28.3 | 41.7 | 28.3 |
| Canyon | Big Creek | 20.0 | 16.7 | 33.3 | 43.3 | 36.7 | 20.0 |
| Cave | Big Creek | 0.0 | 10.3 | 44.8 | 24.1 | 48.3 | 17.2 |
| Cliff | Big Creek | 0.0 | 0.0 | 0.0 | 10.0 | 63.3 | 10.0 |
| Cougar | Big Creek | 0.0 | 0.0 | 0.0 | 0.0 | 33.3 | 27.8 |
| Cow | Big Creek | 3.3 | 3.3 | 6.7 | 36.7 | 0.0 | 23.3 |
| Pioneer | Big Creek | 1.8 | 10.7 | 26.8 | 16.1 | 33.9 | 32.1 |
| Blackmare | SF Salmon | 0.0 | 0.0 | 13.3 | 16.7 | 46.7 | 43.3 |
| Buckhorn | SF Salmon | 0.0 | 0.0 | 10.0 | 6.7 | 13.3 | 30.0 |
| Fitsum | SF Salmon | 0.0 | 0.0 | 6.7 | 13.3 | 43.3 | 3.3 |
| Four Mile | SF Salmon | 0.0 | 0.0 | 6.7 | 3.3 | 20.0 | 13.3 |
| Parks | SF Salmon | 0.0 | 0.0 | 0.0 | 0.0 | 17.9 | 21.4 |
| Reegan | SF Salmon | 0.0 | 3.3 | 0.0 | 6.7 | 13.3 | 33.3 |

| | | % Transects 161-256 mm Substrate | | % Transects >256 mm Substrate | |
|---|---|---|---|---|---|
| Stream | Study Area | Dom | Sub Dom | Dom | Sub Dom |
| Cabin | Big Creek | 1.7 | 15.0 | 6.7 | 6.7 |
| Canyon | Big Creek | 6.7 | 0.0 | 3.3 | 16.7 |
| Cave | Big Creek | 3.4 | 6.9 | 3.4 | 10.3 |
| Cliff | Big Creek | 30.0 | 46.7 | 6.7 | 26.7 |
| Cougar | Big Creek | 38.9 | 27.8 | 16.7 | 33.3 |
| Cow | Big Creek | 3.3 | 0.0 | 10.0 | 3.3 |
| Pioneer | Big Creek | 17.9 | 16.1 | 12.5 | 10.7 |
| Blackmare | SF Salmon | 13.3 | 13.3 | 26.7 | 3.3 |
| Buckhorn | SF Salmon | 40.0 | 26.7 | 33.3 | 33.3 |
| Fitsum | SF Salmon | 6.7 | 50.0 | 36.7 | 30.0 |
| Four Mile | SF Salmon | 10.0 | 60.0 | 63.3 | 16.7 |
| Parks | SF Salmon | 35.7 | 46.4 | 42.9 | 28.6 |
| Reegan | SF Salmon | 26.7 | 33.3 | 60.0 | 23.3 |

Appendix B. Habitat characteristics of 13 streams on the Payette National Forest, Idaho surveyed in July and August 2001.

| | | Pebble | Debris in Net | Debris in Net | Average of 10 Pools Measured | | |
|---|---|---|---|---|---|---|---|
| Stream | Study Area | Anchor | Volume L | Composition | Sediment Depth mm | Pool Size $m^2$ | Pool Depth cm |
| Cabin | Big Creek | 1.8 | 1.6 | 10.7 | 49.2 | 9.9 | |
| Canyon | Big Creek | 1.9 | 0.9 | 10.9 | 41.0 | 2.7 | |
| Cave | Big Creek | 2.1 | 1.0 | 12.4 | 57.9 | 8.9 | |
| Cliff | Big Creek | | 0.2 | | | | |
| Cougar | Big Creek | 2.0 | 0.5 | 14.7 | | | |
| Cow | Big Creek | 1.1 | 2.4 | 3.3 | 166.7 | 4.0 | |
| Pioneer | Big Creek | 2.0 | 0.7 | 12.0 | | | |
| Blackmare | SF Salmon | 1.6 | 1.8 | 10.7 | 87.1 | 9.6 | 40.4 |
| Buckhorn | SF Salmon | 2.2 | 0.7 | 11.8 | 32.8 | 6.8 | |
| Fitsum | SF Salmon | 2.5 | 0.2 | 10.9 | 62.7 | 4.9 | 47.3 |
| Four Mile | SF Salmon | 2.4 | 0.6 | 12.1 | 60.2 | 5.8 | 49.3 |
| Parks | SF Salmon | 2.0 | 0.2 | 12.4 | 23.6 | 6.9 | |
| Reegan | SF Salmon | 2.0 | 1.0 | 10.9 | 42.0 | 8.6 | |

Appendix C.  Locations of temperature data loggers deployed in tributaries of Big Creek, Payette National Forest, Idaho.

| Unit# | Stream | Location (left/right based on facing upstream) | East | North | Datum | Deploy Date | Deploy Time |
|---|---|---|---|---|---|---|---|
| 483601 | Upper Pioneer | Just below drop into flat area above first small stream, attached to tree on right side of stream. | 669370 | 4993119 | Nad27/11 | 9/5/2001 | 14:09 |
| 483602 | Lower Pioneer | Behind fire pit at Taylor Ranch, attached to root on right side of stream. | 669159 | 4996274 | Nad27/11 | 9/5/2001 | 16:13 |
| 483589 | Lower Cliff | ~100 m above bridge near 'tres amigos' dead trees, attached to tree on left side of stream. | 669257 | 4996843 | Nad27/11 | 9/5/2001 | 16:44 |
| 483598 | Lower Cougar | ~30 m above upper edge of meadow, attached to tree on left side of stream. | 671442 | 4996775 | Nad27/11 | 9/6/2001 | 9:50 |
| 483562 | Lower Cabin | Follow west side trail just into canyon, attached to tree on left side of stream. | 662389 | 4999533 | Nad27/11 | 9/7/2001 | 10:34 |
| 483563 | Lower Cow | ~150 m above airstrip, across from cliff on left side of trail, attached to root on right side of stream | 663402 | 5001102 | Nad27/11 | 9/7/2001 | 11:37 |
| 483618 | Lower Ramey | ~100 m up from trail crossing, attached to tree on right side of stream. | 644575 | 5004251 | Nad27/11 | 9/8/2001 | 17:02 |
| 483584 | Upper Cabin | ~30m above confluence North Fork Cabin Creek, attached to tree on left side of stream. | 663261 | 5004501 | Nad27/11 | 9/7/2001 | 13:17 |
| 483605 | Lower Canyon | ~40 m above confluence with Big Creek, attached to tree on left side of stream. | 662407 | 4998686 | Nad27/11 | 9/6/2001 | 16:30 |
| 483586 | Lower Cave | ~40 m above bridge, attached to root on right side of stream. | 660812 | 4999532 | Nad27/11 | 9/8/2001 | 10:48 |